OFFICIAL BULLETIN

of the

ACOUSTICAL MATERIALS ASSOCIATION

THEORY AND USE OF
ARCHITECTURAL ACOUSTICAL MATERIALS

SOUND ABSORPTION COEFFICIENTS

SOUND INSULATION

BULLETIN NO. VIII

PUBLISHED BY THE ASSOCIATION

June, 1941

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Acoustical Materials Association

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Information regarding the Association and its activities can be obtained from the members or their local representatives or by addressing Acoustical Materials Association, Palmolive Bldg., Chicago, Ill.

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Preface

The Acoustical Materials Association is an organization formed by manufacturers of architectural acoustical materials for the purpose of furnishing architects and others reliable technical data on sound absorbing materials and their uses. All manufacturers of such materials are invited to join the Association.

The first part of this booklet attempts to present fundamental technical information in its most simplified form. It is obviously impossible to cover the subject completely in such limited space. The interested reader will find it desirable to refer to the more complete texts on the subject.

The test data contained herein have all been obtained under identical conditions and are therefore comparable. The Association does not wish to discredit other data but, recognizing the confusing differences which have existed in the past, believes that a single set of values approved by all members of the Association is preferable.

In the choice of the test method and other technical matters, the Association has been guided by the recommendations of its Technical Advisory Committee which is composed of leading authorities in the field of architectural acoustics. The Association acknowledges its indebtedness to these men for their helpful coöperation and advice.

Attention is called to the complete description of the samples tested and also to the methods of mounting employed. The absorption of a material may be greatly dependent on these properties and the publication of this detailed information is for the protection of the purchaser. Samples of the original material tested have been distributed to all members of the Technical Advisory Committee where they may be inspected by interested persons.

This bulletin is published periodically so that the public may be kept informed on the latest products of Association members. Interim reports may be made as materials are tested and such reports will appear on the Association letterhead accompanied by the full description of the materials.

Theory and Use of Architectural Acoustical Materials

No ATTEMPT is here made to give a detailed treatment of the well established scientific principles upon which the use of sound absorbent materials is based. This will best be found in tests on the subject such as Watson's "Acoustics of Buildings" (John Wiley & Sons), Knudsen's "Architectural Acoustics" (John Wiley & Sons), and Sabine's "Acoustics and Architecture" (McGraw-Hill).

Since the acoustic properties of an auditorium depend upon many factors such as shape, size, distribution and frequency characteristics of absorbent material, reduction of noise as well as the particular use contemplated, it is recommended that the services of a qualified consultant be retained in the planning of churches, theaters, school auditoriums, and concert halls.

The purpose of this brief outline of the subject is only to acquaint the layman with the terms used in the following tables of data presented by the Acoustical Materials Association and to give the background necessary for their intelligent use.

Pitch

Sound originates at any body that is in a state of vibration and travels as compressional waves in the air with a velocity of about 1120 feet per second. The pitch of a sound depends upon the frequency of vibration of the sounding body. The frequency range of audible sounds is from 20 to 20,000 vibrations per second, although the range of ordinary sounds is much smaller. Doubling the frequency of a musical sound raises the pitch by one octave. The following are approximately the ranges of frequencies covered by a few musical instruments and the human voice.

Piano 27–4186 cycles.
Bass Viol 41–246 cycles.
Cello 65–659 cycles.
Violin 196–2093 cycles.
Flute 261–2093 cycles.
Oboe 233–1568 cycles.
Clarinet (B♭) 73–698 cycles.
Brasses (tubas, trombone, trumpet, cornet) 41–932 cycles.
Female voices 196–1046 cycles.
Male voices 82–466 cycles.

The above are the frequencies of the fundamental tones of instruments and voices. It should be remembered that much of the energy of sounds of both musical instruments and voices is in overtones which have much higher frequencies than those given.

Intensity

The physical intensity of a sound is the vibrational energy transmitted per second through a unit cross section of the sound wave. The ear records differences of frequency as differences in pitch. It registers differences in intensity as differences in loudness. The range of intensities to which the ear responds is enormous. A painfully loud sound at about 1000 cycles has some two and one-half trillion times the physical intensity of a barely audible sound of the same pitch.

Reflection of Sound

Whenever sound strikes a solid barrier a part of its energy is reflected, part is absorbed and part is transmitted to the space beyond. If the sound originates inside a room, the portions absorbed and transmitted by the walls are not returned so we may take the two together under the single heading absorption. We call the fraction that is returned to the room, the reflection coefficient. The fraction not returned is the absorption coefficient.

Echo

When an observer is so placed with reference to a sound reflecting surface that the reflected sound comes to him as a distinct repetition of the direct sound the phenomenon is called an echo.

Multiple Echo

If sound undergoes reflections from a number of surfaces arriving at the ear of the observer with intervening time intervals long enough for him to hear a series of distinct repetitions of the original sound, the effect is called a multiple echo. Suppose as a simple case, that we stand midway between two extended parallel walls 112 feet apart and produce a short sharp sound. The sound travels to each wall and is reflected, traveling a distance of 112 feet. In one-tenth of a second it is returned to the observer. Succeeding to and fro excursions bring a series of repetitions spaced at intervals of one-tenth second, each one fainter than the preceding, due to the fact that a part of the energy is absorbed at each reflection. Suppose that after twenty reflections the intensity drops below the threshold of audibility. Then the multiple echo will persist for two seconds. The mean path of the sound between reflections is 112 feet.

Suppose now we double the distance between the parallel walls, everything else remaining the same. Now the mean path between reflections is 224 feet, the time between successive reflections is $\frac{1}{5}$ of a second, and the total time for the twenty reflections is 4 seconds. Let us assume one further change by supposing that the walls are surfaced with a material having a coefficient of absorption twice that of the original. Then ten instead of twenty reflections will reduce the intensity to the threshold of hearing, and the time for the 224 foot spacing is reduced to two seconds, and for the 112 foot spacing, one second.

Reverberation

Suppose in the preceding case we modify conditions by putting end walls 56 feet apart between the parallel walls assumed to be 112 feet apart, and put a ceiling 28 feet high over the whole thing. We now have a room 112×56 ×28 feet. We shall then have the to and fro reflections between the ends, between the two sides, and between floor and ceiling and in addition across reflections between non-parallel boundaries. The ear will be unable to separate the individual returns as distinct sounds, with the result that the multiple reflections will appear as a mass of sound filling the room with a gradually decreasing intensity. This persistence of sound in a closed space after the sound has ceased is technically known as Reverberation. The time required for this residual sound to decrease to 1/1,000,000 of its initial intensity, or, expressed in decibels, for the intensity level to decrease by 60 db. (10 log 1,000,000 = 60) is called the Reverberation Time of the room.

Effect of Reverberation on Hearing Conditions

If one listens to a speaker close at hand speaking in a quiet tone of voice, the successive syllables arrive at the ear of the listener distinct and free from each other. The speech is easily intelligible. If, however, a speaker raises his voice in a large room, each syllable is prolonged by the reverberation, running more or less into succeeding syllables with resultant confusion and loss of intelligibility. Similarly, the individual notes in music are prolonged by reverberation, and the effect is that of a piano played with the loud pedal held down continuously. The acoustic properties of rooms therefore depend in large measure, though not wholly, upon the reverberation times.

Effect of Volume and Absorption on Reverberation Time

Just as in the simple case of the parallel walls, increasing the distance between the walls increased the time between reflections, so increasing the size of a room *increases* the mean free path of the sound between reflections, and so prolongs the reverberation. Conversely, increasing the average fraction of sound absorbed at each reflection, i.e., the average absorption coefficient, increases the rate of absorption and *diminishes* the period of reverberation. The most commonly used formula for computing the reverberation time is that given by W. C. Sabine, namely

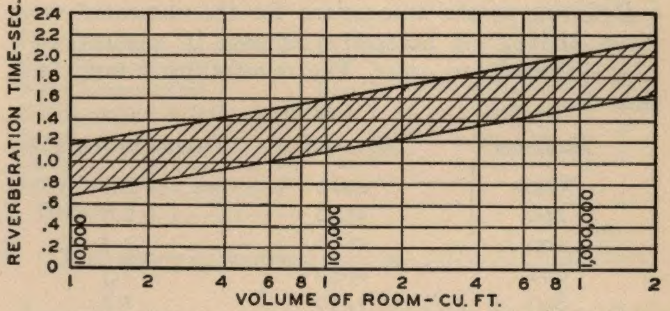
$$T_0 = .05\frac{V}{a}$$

T_0 is the time in which the reverberant sound sinks to 1/1,000,000 of its initial intensity, or for the intensity level to fall 60 db. V is the volume in cubic feet and a is the total absorption of the room. To compute a for any room, the area of each surface is multiplied by its absorption coefficient, and the sum of these plus the absorbing power of objects that may be in the room, seats, furnishings, and, in the case of audience rooms, people, gives us the total absorption, the a of the formula.

Other formulas applying with greater exactness to dead rooms have been proposed and are in use, but most of the data available on desirable reverberation times are based on the simple formula given above. The interested reader is referred to the more recently published texts for detailed discussion.

Desirable Reverberation Times

The Reverberation Time that is desirable for any particular room depends upon a number of considerations. Among them are volume, the usual audience, and the contemplated use, that is, whether the room is intended for music or speech, or both, with or without public address system, or for sound motion pictures and so forth. For this reason, no very precise values of the desirable reverberation time should be given. In rooms such as concert halls or operatic theaters, where good acoustic properties are of paramount importance, careful consideration should be given to all these factors in predetermining the planned reverberation. In the following graph figures within the shaded area represent acceptable reverberation times for various room sizes. These are for the frequency 512 cycles per second. When treating sound film theaters or auditoriums which have a public address system, the reverberation times should fall nearer the lower limit of tolerance. In the case of churches, the times selected should fall nearer the upper limit of tolerance. The correction should be so computed that the correct reverberation time is obtained with an audience of the most probable size present.



Computing Reverberation Time—Numerical Example

While the Reverberation formula is mathematically very simple and its application in rooms of simple shapes is equally so, yet in practice the problem becomes complicated by numerous factors which are not easy to specify, but which have to be taken account of in good acoustical design. For these more complicated cases, reference should be made to the texts cited above, and where good acoustics is a matter of major importance, the designer and builder should be expertly advised. The use of the formula however may be illustrated by computing the reverberation time for the room 112×56×28 feet with the following surfaces and furnishings. The volume and other figures are approximate rather than exact in order to simplify the illustration.

	Dimension	Area	Coef.	Absorbing Power
Floor, cement...............	56′ x 112′	6272 sq. ft.	.015	94 units
Walls, wood panelling........	8′ x 336′	2688	.06	160
Walls, plaster on tile....... ..	20′ x 336′	6720	.025	168
Ceiling, plaster suspended.....	56′ x 112′	6272	.03	188
Velour curtain...............	39′ x 20′	780	.50	390
Total absorbing power, bare room..................................				1000 units

Assume that there are 800 seats each with an absorbing power of .25 units when empty and of 4.3 units when occupied. The volume is $112 \times 56 \times 28 = 175{,}000$ cubic feet. The computed reverberation times under various audience conditions are as follows:

Audience	*Absorption*	$\frac{.05V}{a}$
None	1200 units	7.3 seconds
200	2010	4.3
400	2820	3.1
600	3630	2.4
800	4440	2.0

It will be apparent that the reverberation in this room is excessive without the addition of sound absorbent treatment. Assuming that one-half capacity audience is the most probable figure, we find that the reverberation time should be reduced from 3.1 seconds to 1.5 seconds. The total absorption in the room should be

$$\frac{.05V}{1.5} = 5830 \text{ units.}$$

Referring to the absorptions for the untreated room given above, the necessary increase in absorption is $5830 - 2820 = 3010$ units. The reverberation range will then be:

Audience	*Absorption*	*Reverberation Time*
None	4210	2.1
200	5020	1.7
400	5830	1.5
600	6640	1.3
800	7450	1.2

Reference to the curve will show that for audiences from one-fourth capacity to full capacity this correction gives results within the range of tolerance.

The area of treatment will be found by dividing the necessary added absorption by the coefficient of the material to be used. These areas for materials having coefficients of .40, .60 and .80 are as follows:

Coefficient	*Area Required*
.40	7525 sq. ft.
.60	5017
.80	3762

There may be cases where for architectural reasons the area available for treatment is limited. If in this case only 4500 square feet on the ceiling were available for treatment, there would not be sufficient area for the .40 material or the .60 material. However, a correction could still be obtained for a certain range of audience sizes. The added absorption is $.40 \times 4500 = 1800$ units and $.60 \times 4500 = 2700$ and $.80 \times 4500 = 3600$.

	Reverberation Time		
Audience	.40 material	.60 material	.80 material
None	3.0 sec.	2.3 sec.	1.8 sec.
200	2.3	1.9	1.6
400	1.9	1.6	1.4
600	1.6	1.4	1.2
800	1.4	1.2	1.1

The .40 material gives satisfactory reverberation times from approximately two-thirds to capacity audience; the .60 material gives satisfactory results from approximately one-third to capacity audience; and the .80 material gives results which can be considered satisfactory for any size audience, although the value with a full audience is a little below the optimal reverberation range. In this connection it can be stated that values below the optimal range are generally preferable to values above that range.

The above example shows that considerable latitude is available in the choice of the coefficient of a material. In general, this latitude is greater in rooms having a large amount of absorption in the form of upholstered seats, carpets, draperies, etc., than in rooms with less absorbent furnishings.

If the area of treatment can be varied, then the choice of coefficient to produce a given result is obviously wider.

Reverberation at Different Frequencies

It will be noted in the table of coefficients given herein, that the absorption coefficients of materials are different at different frequencies. It follows accordingly that the reverberation time of a given room will depend upon the pitch of the sound, and that, theoretically at least, the variation with frequency of the absorption coefficient of any material will have an effect upon the acoustic properties of a room in which it is used. It is a common practice to consider the reverberation only at the single frequency 512 vibrations per second. No very definite criterion for reverberation times at other than 512 cycles has been established, but experience shows that in an auditorium with a large area of material having a coefficient at high frequencies several times as great as that at 128 cycles, a preponderance of low pitched sound results which is not pleasing. The importance of considering the coefficients at different frequencies is apparent, in cases such as broadcasting studios in which the artificial absorbent supplies most of the total absorption. In rooms where

only a small portion of the total absorption is supplied by the acoustical material, this factor may be unimportant.

Location of Absorbing Material

The location of absorbing materials must depend upon circumstances to a certain extent. The use of highly absorbent materials on or near the stage is not good practice. Extended rear walls, especially when curved, should be highly absorbent. Normally ceiling areas will be found the most feasible for the installation of acoustical treatment. Treatment applied on under-balcony ceilings is less effective in reducing general reverberation than equal areas applied to ceilings or side walls of the main portion of an auditorium. Choice of materials for any case should be made on the basis of adaptability to the particular demands of the situation rather than on a few points of difference in the absorption coefficients.

Decibel Scale

Instead of specifying the intensities of sounds, acoustical engineers ordinarily refer to the intensity levels expressed in decibels. Two intensity levels differ by one decibel when the difference of the *logarithm* of the corresponding intensities is 0.1. Now the number whose logarithm is 0.1 is 1.26. Hence an increase of 26% in the intensity of a sound corresponds to a rise of 1 decibel in the intensity level. If the minimum audible sound be taken as having a unit intensity, its intensity level is zero, since log 1 = 0. Unless otherwise stated, the intensity level of the sound means the number of decibels above the minimum audible intensity. The accompanying chart will give an idea of the intensity levels of ordinary sounds.

	DECIBELS	
	120	THRESHOLD OF FEELING
DEAFENING	110	THUNDER, ARTILLERY NEARBY RIVETER ELEVATED TRAIN BOILER FACTORY
	100	
VERY LOUD	90	LOUD STREET NOISE NOISY FACTORY TRUCK UNMUFFLED POLICE WHISTLE
	80	
LOUD	70	NOISY OFFICE AVERAGE STREET NOISE AVERAGE RADIO AVERAGE FACTORY
	60	
MODERATE	50	NOISY HOME AVERAGE OFFICE AVERAGE CONVERSATION QUIET RADIO
	40	
FAINT	30	QUIET HOME OR PRIVATE OFFICE AVERAGE AUDITORIUM QUIET CONVERSATION
	20	
VERY FAINT	10	RUSTLE OF LEAVES WHISPER SOUND PROOF ROOM
	0	THRESHOLD OF AUDIBILITY

Noise Level in Rooms

Sound produced in the open air, away from any reflecting surface, travels from the source to the listener, is heard once and that is the end of it. In such a case, moreover, the intensity decreases with increasing distance from the source. In a room, however, repeated reflections prolong each sound, thus building up a general sound level, much greater than would result from the same source without reflection. It can be shown that with a given amount of noise generated in a room, the average intensity of the reflected sound varies inversely as the total absorption of the room, i.e., doubling the absorption halves the physical sound intensity. This does not mean that the ear will judge the loudness of the noise to be half as great. Quantitative judgment of relative loudness is a much more complicated matter.

Reduction of noise in a room resulting from the use of absorbent material can be easily computed by the formula

$$\text{Reduction in decibels} = 10 \log \frac{a_2}{a_1}.$$

The use of this formula is illustrated by the following calculations for a typical office space 40′×50′×10′ high.

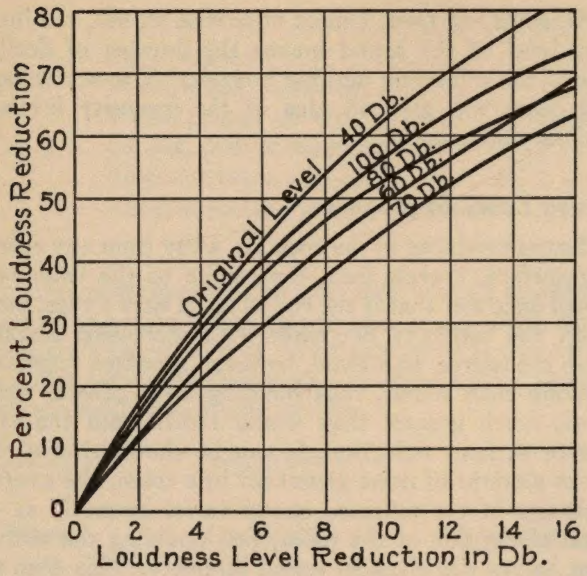
	Area	*Coef.*	*Absorbing Power*
Floor, linoleum	2000 sq. ft.	.03	60 units
Walls, glass windows	300 " "	.03	9 "
Walls, plaster on tile	1500 " "	.025	38 "
Ceiling, plaster on lath	2000 " "	.036	72 "
Desks	20 " "	1.0	20 "
Chairs	20 " "	.2	4 "
File cabinets, etc., and miscellaneous			20 "
Total absorption, untreated room (a_1)			223 units

Assuming that the ceiling area available for treatment is 1800 square feet and that this is covered with materials having noise reduction coefficients of .40, .60, and .80, respectively, the following are obtained.

Coef.	*Net added Absorption*	*Total Absorption after Treatment* (a_2)	a_2/a_1	*Decibel Reduction* 10 log a_2/a_1
.40	655 units	878 units	3.94	6.0 db.
.60	1015 "	1238 "	5.56	7.5 "
.80	1375 "	1598 "	7.17	8.6 "

Judgment of Relative Loudness

It was stated above that the ear does not judge loudness in direct proportion to the physical intensity, but follows a more complex relation. A number of attempts have been made recently to determine this relation experimentally by measuring the differences in intensity



level between two sounds one of which was judged by a group of observers to be half, one-fourth, three-fourths, etc., as loud as the other. Investigators at the Bell Telephone Laboratories have determined a relation between loudness and intensity level which agrees with the results of other experimenters, and which has been adopted by the American Standards Association Committee on Acoustical Measurements and Terminology as a tentative standard. This relation is given in the accompanying chart. (The term "loudness level" need not be defined here, but may be considered for practical purposes as equal to "intensity level" as defined above.) Applying this chart to the example of noise quieting worked out above, the following loudness reductions corresponding to the calculated decibel reductions are obtained.

		Loudness Reduction	
Coef.	*Decibel Reduction*	*60 db. Original Noise Level*	*70 db. Original Noise Level*
.40	6.0	34%	30%
.60	7.5	41	36
.80	8.6	45	40

It will be seen from this table that as in the case of acoustical correction, some tolerance is allowable in the choice of coefficient of the sound absorbing material.

Coefficients of Materials

The sound absorption coefficient of a material is a measure of its efficiency as a sound absorbent which will serve as a basis for computations of reverberation times and of noise reduction. The tables of coefficients presented in the following pages give the results of tests all made under identical conditions in one laboratory. These values were determined for each material by measuring by an electrical method the effect produced by 72 square feet of the material on the rate of decay over a 40 decibel range of reverberant sound in a room whose volume is 10,000 cubic feet. Repeated tests showed that the coefficient obtained by a single test on a given material may, at certain frequencies, vary by as much as 7% of the mean of a large number of tests on that material.

Frequencies for Different Purposes

For *Auditorium Correction*, it has been customary to use the 512 cycle coefficient alone. Since the absorption of a material may vary over a wide range for different frequencies, attention should be paid to the coefficients at other frequencies than this as noted above.

For *Quieting*, the numerical average of the coefficients from 256 to 2048 cycles is recommended as a basis for comparison of different materials.

Sound Insulation

Another type of acoustical problem aside from noise quieting and acoustical correction is that of sound transmission from one room to another through walls, floors, and ceilings. Transmission generally takes place as a result of a floor or wall being set into diaphragmatic vibration, which generates sound waves in the air on the other side. "Airborne transmission" refers to the case where the vibration of the wall or floor is set up by the action of sound waves against its surface, as when the sound of a voice or musical instrument is heard through a partition. "Impact transmission" occurs when vibration is produced by direct mechanical impact on the surface, such as caused by footsteps or the dropping of an object on a floor, or by rigid contact of a vibrating object such as a motor.

Rating Sound Insulating Constructions

The sound insulating efficiency of a wall or floor construction or airborne sound is called its "transmission loss" (T. L.) and is measured in decibels. The transmission loss is simply the number of decibels which a sound loses in being transmitted through the construction. For example, if a sound of 70 db. intensity level passes through a partition having a transmission loss of 30 db., it will have an intensity level of 70 less 30, or 40 db. on the other side. Thus, the loudness of the sound heard through a wall depends both on the original loudness and on the transmission loss of the wall. The higher the original loudness, the greater must be the transmission loss of the wall in order to reduce the loudness to an acceptable level on the other side.

Sound Insulating Methods

From the discussion thus far, it can be seen that the sound insulating efficiency of single walls or floors, which include solid masonry and single stud or joist construction, depends on their ability to resist vibration, which in turn depends chiefly on their weight and rigidity. In general, high efficiency in single constructions can be obtained only by great weight.

High efficiency without excessive weight may be obtained by the use of double wall construction. The efficiency in this case depends partly on the weight and rigidity of the individual members, and to a large extent on the degree of structural isolation between them. The two sides of a double construction should have no rigid contact between them at any point except at the edges. Even a small solid connection, such as a single nail driven through both sides of a double wall, greatly reduces its efficiency by conducting vibration directly across the air space. Good results are also obtained with double construction in which a light facing is attached to a structural wall by specially designed vibration isolating units employing steel springs or felt pads.

The transmission of airborne sound through floors is governed by the same general principles as in the case of walls. Impact transmission, however, involves a few exceptions. For example, a heavy concrete slab is highly effective against airborne sound, but readily transmits impacts made on the bare surface. Simply laying a carpet on the floor surface will greatly reduce the impact transmission, but will have no measurable effect on the airborne transmission. High efficiency against impact transmission is principally a matter either of absorbing the impact before it can get into the floor structure, by means of a resilient floor covering, or of breaking rigid connections between the top and bottom surfaces of the floor structure. This may be done by providing a floating floor surface mounted on resilient supports. In the case of very heavy impacts, as of a person jumping on a floor, satisfactory results can be obtained only with massive, rigid construction, together with the isolating methods just described.

Effect of Sound Absorbing Materials

The question is frequently asked whether the sound transmission between two rooms can be reduced satisfactorily by the use of acoustical treatment. When it is remembered that sound transmission takes place by vibration of the wall or floor surface as a whole, and that it requires a heavy structure to resist this vibration satisfactorily, it will be seen that covering the surface of a wall with a comparatively light acoustical material will not increase its weight or rigidity enough to make any worthwhile improvement in the efficiency of the wall. The use of sound absorbing material in the room where the sound originates reduces the loudness of sound in that room and, therefore, less sound is transmitted through the partition to the room on the other side. This effect would take place regardless of whether the wall itself were treated or whether the same amount of material were placed on another surface in the room. Even so, this indirect reduction in transmission is seldom sufficient to produce satisfactory results. Experience has shown that when transmitted sound is loud enough to cause complaints, a reduction of at least 10 db. is usually necessary to give noticeable improvement.

Sound Leaks

Sound may be said to seek the path of least resistance in passing through a wall or floor. A surprising amount of sound energy will flow through even a small opening in a wall, such as the crack under a door or an enlarged hole around a pipe. This means that good sound insulating construction requires careful workmanship and scrupulous attention to details. All masonry and plaster work should be free from cracks and flaws. If phone or light boxes are to be installed, they should be caulked tight, and should not be placed back to back. Frequently rooms are connected by a common ventilating duct, which may provide a clear path for sound transmission unless it is properly lined with sound absorbing material. In double wall construction, special care must be taken to avoid bridging the air space solidly with nails, extruded mortar, etc.

A frequent error is made in expecting good overall sound insulation from a wall construction of high rated efficiency in which an inefficient door is placed. In such a case, the overall efficiency is not much better than that of the door alone, and in order to obtain the desired results, a door must be used which has an efficiency comparable to that of the wall.

Alphabetical List of Trade Names

For convenient reference the trade names of materials appearing in this bulletin are listed below in alphabetical order, along with the table number and the name of the company under whose listing the product appears. Absorption coefficients and physical characteristics of the products can be found in following tables.

Trade Names	*Table Number*	
Absorbatone	I	Luse-Stevenson Company
Absorbex	I	The Celotex Corporation
Acousteel-B	I	The Celotex Corporation
Acoustex	I	National Gypsum Company
Acousti-Celotex	I	The Celotex Corporation
Acoustimetal	I	National Gypsum Company
Acoustone	I	United States Gypsum Company
Airacoustic	I	Johns-Manville Sales Corporation
Calicel	I	The Celotex Corporation
Calistone	I	The Celotex Corporation
Corkoustic	I	Armstrong Cork Company
Cushiontone	I	Armstrong Cork Company
Econacoustic	I	National Gypsum Company
Fiberglas Acoustical Tile	I	Owens-Corning Fiberglas Corporation
Fiberglas Decorative Acoustical Blanket	I	Owens-Corning Fiberglas Corporation
Fiberglas Metal Mesh Blanket	III	Owens-Corning Fiberglas Corporation
Fiberglas Semi-Rigid Panels and Boards	III	Owens-Corning Fiberglas Corporation
Fiberglas Sewn Blanket	III	Owens-Corning Fiberglas Corporation
Fibracoustic	I	Johns-Manville Sales Corporation
Fibretex	I	Johns-Manville Sales Corporation
Kencoustic	I	David E. Kennedy, Inc.
Koustex	I	David E. Kennedy, Inc.
Macoustic Plaster	II	National Gypsum Company
Muffletone	I	The Celotex Corporation
Perfatone	I	United States Gypsum Company
Permacoustic	I	Johns-Manville Sales Corporation
Q-T Ductliner	I	The Celotex Corporation
Reverbolite Acoustical Plaster	II	The Celotex Corporation
Sabinite Acoustical Plaster	II	United States Gypsum Company
Sanacoustic	I	Johns-Manville Sales Corporation
Sound Isolation Blanket	I	Johns-Manville Sales Corporation
Transite Acoustical Unit	I	Johns-Manville Sales Corporation
Travacoustic	I	National Gypsum Company

Light Reflection Values

All light reflection values on acoustical materials listed in the following tables are obtained from tests conducted at a laboratory chosen by the Association. The tests are made on samples selected by a representative of the testing laboratory as typical of the actual material submitted for sound absorption tests. The light reflection is measured in a type of reflectometer known as the "Baumgartner sphere" described in the "Transactions of the Illuminating Engineering Society," 33, 379 (1938). Each value reported is the average of measurements on four (4) samples.

The letter appearing in the tables under the column heading "Color" indicates the color of the sample which gave the light reflection value in the adjoining column, in accordance with the following table:

W—White

I—Ivory

C—Cream

B—Buff

Wp—White, perforated. This symbol used only when surface is combination of perforated and unperforated units.

Wu—White, unperforated. This symbol used only when surface is combination of perforated and unperforated units.

Classification by Types

In writing specifications for acoustical materials it is frequently desirable to have the available products classified with respect to their appearance when installed. The appearance depends principally upon the texture and composition of the face of the material and upon the presence or absence of fissures or mechanical perforations

To assist architects and others who desire to specify materials by types, the Association has established the following classifications and the type of each material is indicated accordingly in the tables which appear on following pages.

This classification agrees exactly with Federal Specification for Acoustical-Units; Prefabricated SS-A-118.

I. Cast units composed of small uniform mineral particles held together with Portland cement.

II. Cast units having a surface composed of or resembling small uniform granules. The binder may be gypsum or any other suitable mineral binder.

III. Cast units having a surface composed of or resembling irregular, rough granules. The binder may be gypsum or any other suitable mineral binder.

IV. Units having a mechanically perforated surface, which acts as a covering for the sound absorbent material.

V. Units which are mechanically perforated, the perforations extending into the sound absorbent material.

VI. Units having a fissured surface.

VII. Compressed units composed of long wood fibers held together with a mineral binder. This type shall not have a mechanically perforated surface.

VIII. Felted fiber or wood pulp units which have a surface that is not mechanically perforated.

Absorption Coefficients and Specifications of Test Samples

TABLE NO. I

ACOUSTICAL UNITS AND BLANKETS

Types of Mounting

1. Cemented to plaster board. Considered equivalent to cementing to plaster or concrete ceiling.
2. Nailed to 1″ x 2″ wood furring 12″ o.c. unless otherwise indicated.
3. Attached to metal supports applied to 1″ x 2″ wood furring.
4. Laid directly on laboratory floor.
5. Nailed to 1″ x 3″ wood furring 24″ o.c. and filled in between furring with 1″ mineral wool, .35 lbs./sq. ft.
6. Laid on 24 ga. sheet iron, nailed to 1″ x 2″ wood furring 24″ o.c.
7. Attached to special metal supports mounted on 2″ x 2″ wood furring.
8. Nailed to 2″x2″ wood furring 18″ or 20″ o.c. 2″ mineral wool between furring.

ARMSTRONG CORK COMPANY

Material	†Thickness	Type (Described on page 11)	Mounting (Described above)	Coefficients						*Noise Red. Coef.	Unit Size Tested	Light Reflection (Described on page 11)		Wt. (lbs.) Sq. Ft.	Surface	Test No.
				128	256	512	1024	2048	4096			Color	Value			
Corkoustic B4	1-1/4″	VI	1	.08	.13	.51	.75	.47	.46	.45	12″ x 12″	W I B	.79 .70 .65	.68	Painted by mfgr.	39–30
Corkoustic B4	1-1/4″	VI	2	.11	.34	.67	.47	.57	.53	.50	12″ x 12″			.68	Same as above.	39-29
Corkoustic B5	1-1/2″	VI	1	.06	.16	.73	.69	.56	.89	.55	12″ x 12″			.77	Same as above.	41-28
Corkoustic B5	1-1/2″	VI	2	.18	.41	.70	.51	.58	.65	.55	12″ x 12″			.77	Same as above.	41-27
Corkoustic B6	1-3/4″	VI	1	.15	.28	.82	.60	.58	.38	.55	12″ x 12″			.94	Same as above.	39-27
Corkoustic B6	1-3/4″	VI	2	.22	.55	.61	.54	.51	.50	.55	12″ x 12″			.94	Same as above.	39-26
Cushiontone A1	1/2″	V	1	.05	.18	.58	.72	.71	.71	.55	12″ x 12″	W I	.72 .73	.70	Painted by mfgr. Perforated 484 holes per sq. ft., 3/16″ diam., 3/8″ deep.	41-73
Cushiontone A1	1/2″	V	2	.10	.45	.56	.61	.73	.64	.60	12″ x 12″			.70	Same as above.	41-70
Cushiontone A2	5/8″	V	1	.13	.35	.59	.70	.73	.74	.60	12″ x 12″			.92	Painted same as above. Perforated same as above, 1/2″ deep.	41-74
Cushiontone A2	5/8″	V	2	.11	.54	.53	.64	.70	.73	.60	12″ x 12″			.92	Same as above.	41-71
Cushiontone A3	7/8″	V	1	.13	.39	.75	.94	.81	.70	.70	12″ x 12″			1.17	Painted same as above. Perforated same as above, 3/4″ deep.	41-75
Cushiontone A3	7/8″	V	2	.17	.58	.70	.90	.76	.71	.75	12″ x 12″			1.17	Same as above.	41-72

DAVID E. KENNEDY, INC.

Material	†Thickness	Type	Mounting	128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Kencoustic	1-1/2″	VI	1	.05	.13	.61	.71	.56	.60	.50	9″ x 18″			1.08	Painted by mfgr.	39-75
Koustex	1″	VII	1	.10	.24	.64	.92	.77	.75	.65	12″ x 24″			1.58	Unpainted.	41-41
Koustex	1″	VII	2	.15	.27	.75	.99	.80	.87	.70	12″ x 24″			1.70	Painted by mfgr.	41-14

JOHNS-MANVILLE SALES CORPORATION

Material	†Thickness	Type (Described on page 11)	Mounting (Described on page 12)	Coefficients 128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Light Reflection (Described on page 11) Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Sanacoustic, pad plus metal facing and pad supports plus furring	1-1/8" 1-9/16" 2-1/2"	IV	3	.25	.56	.99	.99	.91	.82	.85	12" x 24"	W	.76	Pad 1.25	Perforated enameled metal .068" diameter perforations, 4608 per sq. ft.	39-86
Sanacoustic, pad plus metal facing and pad supports plus furring	1-1/8" 1-9/16" 2-1/2"	IV	3	.22	.70	.63	.67	.52	.48	.65	12" x 24"	Wp Wu	.76 .85	Pad 1.31	50/50 Pattern, one-half perforated enameled metal backed with pads, .068" diam., 4608 holes/sq. ft.; one-half enameled metal unperforated, unbacked.	41-67
Transite Acoustical Unit, pad plus Transite facing	1" 1-1/8"	IV	2	.28	.55	.83	.91	.76	.67	.75	12" x 12"	W	.72	2.20	Painted by mfgr. 576 holes per sq./ft. 5/32" diameter.	39-59
Permacoustic	3/4"	VI	1	.19	.34	.74	.76	.75	.74	.65	12" x 12"	W	.73	1.82	Unpainted.	39-87
Permacoustic	1"	VI	1	.23	.44	.71	.68	.70	.73	.65	12" x 12"	W	.85	2.36	Painted by mfgr.	40-94
Fibracoustic	1"	VIII	1	.17	.43	.79	.93	.79	.73	.75	12" x 12"	W	.69	.59	Painted by mfgr.	40-27
Fibracoustic	1"	VIII	2	.18	.65	.82	.83	.85	.83	.80	12" x 12"	W	.69	.59	Same as above.	40-26
Sound Isolation Blanket MK	1/2"		4	.05	.13	.48	.81	.86	.80	.55				.54	Muslin covered, unpainted.	41-32
Sound Isolation Blanket MK	1"		4	.15	.37	.89	.98	.89	.86	.80				1.04	Muslin covered, unpainted.	41-33
Sound Isolation Blanket MK	2"		4	.43	.64	.97	.99	.87	.90	.85				2.33	Muslin covered, unpainted.	41-13
Fibretex	5/8"	VII	2	.09	.16	.45	.84	.77	.66	.55	12" x 12"			1.32	Painted by mfgr.	41-60
Fibretex	3/4"	VII	2	.09	.17	.59	.90	.75	.73	.60	12" x 12"			1.71	Same as above.	41-61
Fibretex	7/8"	VII	2	.09	.25	.67	.91	.78	.80	.65	12" x 12"			1.91	Same as above.	41-62
Fibretex	1"	VII	2	.14	.28	.81	.94	.83	.80	.70	12" x 12"			2.36	Same as above.	41-63
Airacoustic	1/2"	VIII	6	.22	.31	.48	.73	.86	.76	.60	24" x 36"			.87	Unpainted.	39-93
Airacoustic	1"	VIII	6	.44	.44	.74	.80	.93	.74	.75	24" x 36"			1.6	Unpainted.	39-94
Airacoustic	1-1/2"	VIII	6	.50	.44	.67	.78	.86	.87	.70	24" x 36"			1.94	Unpainted.	41-12

* The noise reduction coefficient is the average of the coefficients at frequencies from 256 to 2048 cycles inclusive, given to the nearest 5%. This average coefficient is recommended for use in comparing materials for noise quieting purposes as in offices, hospitals, banks, corridors, etc.

For auditorium treatment, attention should be directed to the coefficients at 512 cycles and other frequencies es explained elsewhere.

† Unless otherwise noted, the thickness given is the thickness of the sound-absorbing element forming the face of the construction. The thickness of other sound-absorbing elements in the construction, if used, is indicated by the type of mounting.

TABLE NO. I (Continued)

LUSE-STEVENSON CO.

Material	†Thickness	Type (Described on page 11)	Mounting (Described on page 12)	Coefficients 128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Light Reflection (Described on page 11) Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Absorbatone A	1"	VII	2 (24" o.c.)	.15	.28	.82	.99	.87	.98	.75	12" x 24"			2.4	Unpainted.	40-32
Absorbatone A	1"	VII	2 (24" o.c.)	.11	.29	.80	.99	.80	.96	.70	12" x 24"			2.5	Painted by mfgr.	40-38
Absorbatone A	1"	VII	5	.25	.55	.99	.99	.85	.96	.85	12" x 24"			2.5	Same as above.	40-39

NATIONAL GYPSUM COMPANY

Material	†Thickness	Type	Mounting	128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Acoustex 30R	5/8"	VII	2	.09	.16	.45	.84	.77	.66	.55	12" x 12"			1.32	Painted by mfgr.	41-60
Acoustex 30R backed by 1" rock wool	5/8"	VII	2	.17	.38	.98	.96	.85	.75	.80	12" x 12"			Unit 1.70	Same as above.	39-33
Acoustex 40R	3/4"	VII	2	.09	.17	.59	.90	.75	.73	.60	12" x 12"			1.71	Same as above.	41-61
Acoustex 40R	3/4"	VII	7	.18	.35	.87	.89	.87	.65	.75	12" x 12"	W	.79	1.66	Same as above.	40-17
Acoustex 50R	7/8"	VII	2	.09	.25	.67	.91	.78	.80	.65	12" x 12"			1.91	Same as above.	41-62
Acoustex 60R	1"	VII	2	.14	.28	.81	.94	.83	.80	.70	12" x 12"			2.36	Same as above.	41-63
Acoustimetal, Type P pad plus metal facing and pad supports plus furring	1-1/4" 1-5/8" 2-1/2"	IV	3	.23	.63	.99	.98	.78	.62	.85	12" x 24"			Pad 1.02	Perforated enameled metal .068" diameter perforations, 4608 per sq. ft.	39-25
Econacoustic	1/2"	VIII	1	.05	.31	.54	.84	.76	.90	.60	12" x 12"			.39	Painted by mfgr.	40-31
Econacoustic	1/2"	VIII	2	.09	.39	.73	.71	.78	.82	.65	12" x 12"			.39	Same as above.	40-30
Econacoustic	1"	VIII	1	.25	.40	.78	.76	.79	.68	.70	12" x 12"	W	.84	.79	Same as above.	40-10
Travacoustic	1"	VI	1	.14	.29	.80	.98	.85	.74	.75	12" x 12"	W	.74	2.09	Unpainted.	40-18

OWENS-CORNING FIBERGLAS CORPORATION

Material	†Thickness	Type	Mounting	128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Fiberglas Acoustical Tile, Type TW-PF 9D	1/2"		2	.08	.24	.67	.93	.71	.46	.65	12" x 12"	I	.68	.61	Painted by mfgr.	40-41
Fiberglas Acoustical Tile, Type TW-PF 9D	1"		2	.22	.46	.97	.90	.68	.52	.75	12" x 12"	C	.67	.75	Same as above.	39-83
Fiberglas Decorative Acoustical Blanket	1"		2	.26	.40	.70	.93	.88	.82	.75		I	.73	.18	Fiberglas cloth.	40-12

Material	†Thickness	Type (Described on page 11)	Mounting (Described on page 12)	Coefficients 128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Light Reflection (Described on page 11) Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Acoustone D	9/16″	VI	1	.06	.16	.61	.90	.82	.82	.60	12″ x 12″			1.08	Unpainted.	39-68
Acoustone D	9/16″	VI	1	.08	.21	.70	.87	.71	.66	.60	12″ x 12″			1.16	Painted by mfgr.	39-73
Acoustone D	11/16″	VI	1	.08	.22	.73	.91	.81	.85	.65	12″ x 12″	W I C	.71 .61 .57	1.31	Unpainted.	39-67
Acoustone D	11/16″	VI	1	.13	.26	.79	.88	.76	.74	.65	12″ x 12″	W	.83	1.30	Painted by mfgr.	39-74
Acoustone D	13/16″	VI	1	.15	.26	.79	.92	.85	.85	.70	12″ x 12″			1.41	Unpainted.	39-46
Acoustone D	13/16″	VI	1	.11	.30	.81	.88	.77	.76	.70	12″ x 12″			1.48	Painted by mfgr.	39-61
Acoustone D	15/16″	VI	1	.20	.40	.84	.88	.85	.88	.75	12″ x 12″			1.53	Unpainted.	39-47
Acoustone D	15/16″	VI	1	.12	.37	.83	.88	.83	.80	.75	12″ x 12″			1.66	Painted by mfgr.	39-60
Acoustone F	9/16″	VI	1	.11	.12	.44	.89	.90	.93	.60	12″ x 12″			.95	Unpainted.	39-54
Acoustone F	9/16″	VI	1	.04	.12	.53	.95	.85	.85	.60	12″ x 12″			1.01	Painted by mfgr.	39-69
Acoustone F	11/16″	VI	1	.14	.17	.65	.93	.85	.89	.65	12″ x 12″			1.15	Unpainted.	39-57
Acoustone F	11/16″	VI	1	.04	.18	.75	.96	.80	.80	.65	12″ x 12″			1.22	Painted by mfgr.	39-70
Acoustone F	13/16″	VI	1	.14	.26	.81	.88	.85	.83	.70	12″ x 12″			1.43	Unpainted.	39-53
Acoustone F	13/16″	VI	1	.16	.33	.85	.89	.80	.75	.70	12″ x 12″	W	.76	1.47	Painted by mfgr.	39-71
Acoustone F	15/16″	VI	1	.16	.31	.87	.92	.83	.87	.75	12″ x 12″	W I C	.64 .58 .56	1.62	Unpainted.	39-63
Acoustone F	15/16″	VI	1	.16	.33	.91	.87	.83	.88	.75	12″ x 12″			1.67	Painted by mfgr.	39-72
Perfatone, pad	1-1/4″	IV	3	.23	.59	.98	.99	.87	.68	.85	12″ x 24″			Pad .88	Perforated enameled metal, 4608 holes per sq. ft., .073″ diameter.	40-79
plus metal facing and pad supports	1-5/8″															
plus furring	2-1/2″															

* The noise reduction coefficient is the average of the coefficients at frequencies from 256 to 2048 cycles inclusive, given to the nearest 5%. This average coefficient is recommended for use in comparing materials for noise quieting purposes as in offices, hospitals, banks, corridors, etc.

For auditorium treatment, attention should be directed to the coefficients at 512 cycles and other frequencies as explained elsewhere.

† Unless otherwise noted, the thickness given is the thickness of the sound-absorbing element forming the face of the construction. The thickness of other sound-absorbing elements in the construction, if used, is indicated by the type of mounting.

TABLE NO. I (Continued)

THE CELOTEX CORPORATION

Material	†Thickness	Type (Described on page 11)	Mounting (Described on page 12)	Coefficients 128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Light Reflection (Described on page 11) Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Acousti-Celotex, Type C-1	1/2"	V	1	.07	.14	.57	.59	.64	.63	.50	12" x 12"	W	.83	.76	Painted by mfgr. Perforated 441 holes per sq. ft. 3/16" diameter, 3/8" deep.	41-55
Acousti-Celotex, Type C-1	1/2"	V	2	.11	.54	.45	.53	.58	.64	.55	12" x 12"	W	.83	.76	Same as above.	41-52
Acousti-Celotex, Type C-2	5/8"	V	1	.16	.20	.67	.78	.69	.59	.60	12" x 12"			.88	Painted by mfgr. Perforated same as above, 1/2" deep.	41-23
Acousti-Celotex, Type C-2	5/8"	V	2	.17	.55	.59	.67	.65	.58	.60	12" x 12"			.88	Same as above.	41-20
Acousti-Celotex, Type C-3	13/16"	V	1	.15	.27	.82	.94	.63	.52	.65	12" x 12"			1.02	Painted by mfgr. Perforated same as above, 11/16" deep.	41-24
Acousti-Celotex, Type C-3	13/16"	V	2	.22	.50	.76	.84	.66	.40	.70	12" x 12"			1.03	Same as above.	321
Acousti-Celotex, Type C-3	13/16"	V	7	.22	.56	.76	.87	.60	.25	.70	12" x 24"	W	.83	1.11	Same as above.	40-43
Acousti-Celotex, Type C-4	1-1/4"	V	1	.13	.35	.99	.81	.60	.50	.70	12" x 12"	W C I	.82 .77 .63	1.48	Painted by mfgr. Perforated same as above, 1-1/8" deep.	41-26
Acousti-Celotex, Type C-4	1-1/4"	V	2	.28	.56	.98	.78	.59	.49	.75	12" x 12"	W C I	.82 .77 .63	1.48	Same as above.	41-25
Acousti-Celotex, Type C-5	13/16"	V	1	.12	.20	.78	.94	.83	.62	.70	12" x 12"			1.06	Painted by mfgr. Perforated 441 holes per sq. ft. 1/4" diameter, 11/16" deep.	41-30
Acousti-Celotex, Type C-6	1-1/4"	V	2	.30	.56	.94	.96	.69	.56	.80	12" x 12"	W C I	.79 .72 .59	1.45	Painted by mfgr. Perforated same as above, 1-1/8" deep.	41-31
Acousti-Celotex, Type C-8	1"	V	2	.31	.47	.58	.73	.73	.60	.65	24" x 24"	I	.60	1.3	Painted by mfgr. Perforated 441 holes per sq. ft. 3/16" diameter, 7/8" deep.	41-29
Acousti-Celotex, Type M-1	5/8"	V	1	.10	.15	.55	.85	.89	.76	.60	12" x 12"			1.57	Painted by mfgr. Perforated 676 holes per sq. ft. 5/32" diameter, 1/2" deep.	41-21
Acousti-Celotex, Type M-1	5/8"	V	2	.17	.43	.53	.79	.88	.66	.65	12" x 12"			1.54	Same as above.	320
Acousti-Celotex, Type M-2	1"	V	1	.12	.26	.82	.99	.80	.67	.70	12" x 12"	W C	.84 .79	2.52	Painted by mfgr. Perforated same as above, 7/8" deep.	41-22
Acousti-Celotex, Type M-2	1"	V	7	.22	.53	.69	.99	.74	.63	.75	12" x 24"	W	.82	2.5	Same as above.	40-44
Calicel, Standard	3/4"	II	1	.12	.15	.47	.95	.78	.72	.60	12" x 12"			2.37	Painted by mfgr.	41-35
Calicel, Standard	1"	II	1	.11	.17	.66	.95	.74	.75	.65	12" x 12"	W	.65	2.92	Same as above.	41-36
Calistone, SW	1"	I	4	.08	.14	.40	.76	.66	.60	.50	12" x 12"	W	.59	5.85	Unpainted.	41-34
Absorbex, Type A	1"	VII	1	.13	.23	.70	.99	.79	.84	.70	18" x 18"	W	.68	2.68	Painted by mfgr.	41-68
Absorbex, Type A	1"	VII	2 (18" o.c.)	.17	.34	.85	.94	.84	.87	.75	18" x 18"	W	.68	2.68	Same as above.	41-48
Absorbex, Type A	1"	VII	8 (18" o.c.)	.41	.71	.96	.88	.85	.96	.85	18" x 18"	W	.68	Unit 4.98	Same as above.	41-65
Absorbex, Type F	1"	VII	1	.15	.18	.59	.93	.61	.67	.60	20" x 32"			2.53	Same as above.	41-66
Absorbex, Type F	1"	VII	2	.11	.22	.73	.72	.77	.75	.60	20" x 32"			2.53	Same as above.	41-47
Absorbex, Type F	1"	VII	8 (20" o.c.)	.37	.77	.91	.70	.73	.63	.80	20" x 32"			Unit 4.83	Same as above.	41-64

THE CELOTEX CORPORATION (Continued)

Material	†Thickness	Type (Described on page 11)	Mounting (Described on page 12)	Coefficients 128	256	512	1024	2048	4096	*Noise Red. Coef.	Unit Size Tested	Light Reflection (Described on page 11) Color	Value	Wt. (lbs.) Sq. Ft.	Surface	Test No.
Absorbex, Type F	2"	VII	1	.20	.43	.99	.67	.90	.71	.75	20" x 32"			4.19	Same as above.	41-46
Muffletone (Std.)	3/4"	II	1	.17	.29	.63	.75	.74	.80	.60	12" x 12"	W	.58	1.48	Unpainted.	39-66
Muffletone (Std.)	1"	II	1	.18	.40	.72	.79	.79	.77	.70	12" x 12"	W	.67	1.79	Painted by mfgr.	39-32
Acousteel-B, pad plus metal facing and supports plus furring	1-1/4" 1-5/8" 2-1/2"	IV	3	.29	.57	.98	.99	.85	.57	.85	12" x 24"	W	.70	Pad .91	Perforated enameled metal .068" diameter perforations, 4608 per sq. ft.	40-92
Acousteel-B, pad plus metal facing and supports plus furring	1-1/4" 1-5/8" 2-1/2"	IV	3	.25	.66	.71	.71	.55	.49	.65	12" x 24"			Pad .91	50/50 Pattern, one-half perforated enameled metal, backed with pads, same as above; one-half enameled metal unperforated, without pads.	40-96
Q-T Ductliner	1/2"	VIII	6	.14	.38	.43	.76	.75	.75	.60	24" x 36"			.57	Unpainted.	40-97
Q-T Ductliner	1"	VIII	6	.29	.41	.78	.89	.88	.78	.75	22" x 32"			1.24	Unpainted.	40-70

* The noise reduction coefficient is the average of the coefficients at frequencies from 256 to 2048 cycles inclusive, given to the nearest 5%. This average coefficient is recommended for use in comparing materials for noise quieting purposes as in offices, hospitals, banks, corridors, etc.

For auditorium treatment, attention should be directed to the coefficients at 512 cycles and other frequencies as explained elsewhere.

† Unless otherwise noted, the thickness given is the thickness of the sound-absorbing element forming the face of the construction. The thickness of other sound-absorbing elements in the construction, if used, is indicated by the type of mounting.

TABLE NO. II

ACOUSTICAL PLASTERS

Each sample of acoustical plaster was mixed and applied by a skilled plasterer, according to specifications furnished by the manufacturer. The acoustical plaster was applied to panels mounted on a ceiling under conditions that might be expected to exist on normal jobs. All samples were applied to a 3/4″ dry base coat on metal lath nailed to 1″ x 2″ furring. The panels so made were laid on the floor of the Sound Chamber for tests.

NATIONAL GYPSUM COMPANY

Material	Thick-ness	Coefficients						*Noise Reduction Coefficient	Number of Coats	Base Coat	Wt. of dry acoustical plaster per sq. yd.	Application	Surface Treatment	Test No.
		128	256	512	1024	2048	4096							
Macoustic Plaster, Type 55V, Trowel finish	1/2″	.32	.24	.53	.81	.68	.67	.55	1st coat 1/4″ 2nd coat 1/4″	gypsum plaster	10.9	1st coat applied to dry base. 2nd coat applied after 1 day interval.	Finished with steel trowel.	41-82

THE CELOTEX CORPORATION (AMERICAN GYPSUM DIVISION)

Reverbolite Acoustical Plaster	1/2″	.29	.30	.40	.49	.54	.60	.45	2	gypsum plaster	14 lbs.	1st coat applied to dry base. 2nd coat applied same day.	Stippled with rice brush.	349
Reverbolite Acoustical Plaster	1/2″	.26	.26	.47	.57	.65	.59	.50	2	gypsum plaster	14 lbs.	1st coat applied to dry base. 2nd coat applied same day.	Finished with steel trowel.	350

UNITED STATES GYPSUM COMPANY

Sabinite Acoustical Plaster	1/2″	.26	.16	.32	.70	.73	.72	.50	1st coat 1/4″ 2nd coat 1/4″	gypsum plaster	17.6	2nd coat applied day after 1st coat.	Floated with cork float.	41-69

* The noise reduction coefficient is the average of the coefficients at frequencies from 256 to 2048 cycle inclusive, given to the nearest 5%. This average coefficient is recommended for use in comparing materials for noise quieting purposes as in offices, hospitals, banks, corridors, etc.

For auditorium treatment, attention should be directed to the coefficients at 512 cycles and other frequencies as explained elsewhere.

TABLE NO. III

COEFFICIENTS OF GENERAL BUILDING MATERIALS

Complete tables of coefficients of the various materials that normally constitute the interior finish of rooms may be found in the various books on architectural acoustics. The following short list will be useful in making simple calculations of the reverberation in rooms.

Material	*Coefficients*		
	128	512	2048
Brick wall, painted	.012	.017	.023
Same, unpainted	.024	.03	.049
Carpet, unlined	.09	.20	.27
Same, felt lined	.11	.37	.27
Fabrics, hung straight			
Light, 10 ozs. per sq. yd.	.04	.11	.30
Medium, 14 ozs. per sq. yd.	.06	.13	.40
Heavy, draped, 18 ozs. per sq. yd.	.10	.50	.82
Floors			
Concrete or terrazzo	.01	.015	.02
Wood	.05	.03	.03
Linoleum, asphalt, rubber or cork tile on concrete		.03–.08	
Glass	.035	.027	.02
Glass Fibre Blankets and Semi-Rigid Boards			
*Fiberglas Semi-Rigid Panels and Boards, tested lying on laboratory floor.			
Type TW-PF—2.5D 1" thick, .23 lbs. per sq. ft.	.24	.65	.73
Type TW-PF— 4D 1" thick, .34 lbs. per sq. ft.	.20	.75	.86
Type TW-PF— 4D 2" thick, .71 lbs. per sq. ft.	.41	.99	.84
Type TW-PF— 6D 1" thick, .47 lbs. per sq. ft.	.25	.86	.84
Type TW-PF—12D 1" thick, 1.04 lbs. per sq. ft.	.09	.79	.87
*Fiberglas Metal Mesh Blankets (Style HO), tested lying on laboratory floor.			
Type TW-G—2D 1" thick, .42 lbs. per sq. ft.	.24	.57	.70
Type TW-G—2D 2" thick, .64 lbs. per sq. ft.	.38	.84	.76
Type TW-G—4D 1" thick, .58 lbs. per sq. ft.	.33	.81	.78
Type TW-G—4D 2" thick, .97 lbs. per sq. ft.	.54	.99	.88
Type TW-G—6D 1" thick, .75 lbs. per sq. ft.	.35	.89	.87
Type TW-G—6D 2" thick, 1.31 lbs. per sq. ft.	.55	.99	.91
*Fiberglas Sewn Blankets—Muslin Faced (Styles PM 2 or FM 2), tested lying on laboratory floor.			
Type TW-G—4D 2" thick, .69 lbs. per sq. ft.	.62	.99	.86
Marble or Glazed Tile	.01	.01	.015
Openings			
Stage, depending on furnishings		.25–.75	
Deep balcony, upholstered seats		.50–1.00	
Grills, ventilating		.15–.50	
Plaster, gypsum or lime, smooth finish on tile or brick	.013	.025	.04
Same, on lath	.02	.03	.04
Plaster, gypsum or lime, rough finish on lath	.039	.06	.054
Wood Panelling	.08	.06	.06

*Data preceded by an asterisk indicates that the material was tested in the A.M.A. laboratory under test conditions specified by the Association.

ABSORPTION OF SEATS AND AUDIENCE

Audience, seated, units per person, depending on character of seats, etc.	1.0–2.0	3.0–4.3	3.5–6.0
Chairs, metal or wood	.15	.17	.20
Pew Cushions	.75–1.1	1.45–1.90	1.4–1.7
Theatre and Auditorium Chairs			
Wood veneer seat and back		.25	
Upholstered in leatherette		1.6	
Heavily upholstered in plush or mohair		2.6–3.0	
Wood Pews		.40	

Recommendations to Architects and Engineers

For the improvement of technical and competitive conditions in the industry, the members of the Association and Technical Advisory Committee make the following recommendations.

Expert Services

Since the acoustic properties of an auditorium depend upon many factors other than reverberation time, such factors including shape, size, distribution and frequency characteristics of absorbent material, reduction of noise and the particular uses contemplated, it is recommended that the services of qualified consultants be retained in the planning of churches, theaters, school auditoriums and concert halls, and that specifications for acoustical treatment be made under competent advice from independent consultants.

Guarantees

In view of the experimental difficulties in precise measurements of reverberation times under field conditions, and the occasional rather wide departure from theory in exceptional cases, it is recommended that no guarantees of reverberation times be made by manufacturers or erectors. Guarantees should cover only the point that the materials sold have substantially the same absorbing efficiencies as the samples submitted for tests, values of which are given in the Association lists. In order to carry out this guarantee, original test samples of materials are preserved at the testing laboratory for comparison in case any question arises as to the essential identity of commercial products and test samples. Further single units of each of the materials tested will be in the possession of each member of the Advisory Committee. A material which departs not more than 10% of the value of the published coefficient from that value should be considered as fulfilling the terms of such a guarantee.

Rating of Materials

In order not to emphasize unduly the precise value of the absorption coefficient of a material, it should be borne in mind that experiments show that the results of a single measurement of the coefficient of a material may, at certain frequencies, depart from the mean of a large number of measurements by as much as 7% of the mean value. Minor differences in coefficient, therefore, should be disregarded in choosing between materials and attention given to the many other properties of the materials.

Coefficients to Be Considered in Auditorium Treatment

While long usage has established the practice of computing reverberation times at the single frequency 512 cycles, yet consideration should be given to the absorption coefficients at other frequencies.

Coefficients for Noise Reduction

In considering materials for the reduction of noise, as in quieting of offices, hospitals, banks, corridors, etc., the 512 cycle value above should not be used alone. With the information available at the present time it is recommended that the average value of the coefficients from 256 to 2048 cycles inclusive should be used. This average value of each material, to the nearest 5%, is listed in the tables as the "Noise Reduction Coefficient" of the material.

Application of Materials

Acoustical materials are properly classified as "building specialties" the proper use and installation of which can best be intrusted to persons familiar with them. The members of the Association will gladly refer you to representatives in all localities who are skilled in the application of their products.